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A MULTI-LAYER SCENARIO ANALYSIS FOR SUSTAINABLE INTERNATIONAL TRANSPORT

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This article considers the development of the international transport sector based on four globalization scenarios. These four images of the future transportation market are constructed at three different levels (global, European and Dutch). The possible consequences of these scenarios are mapped out not only by key aspects such as modal split and spatial organization but also by providing empirical insights into expected transport flows for both passenger and freight transport in 2020 based on data from 1995.

Keywords: Globalization; Scenarios; Transport; Spatial organization

1. INTRODUCTION

An efficient transport system is a crucial precondition for economic development and an asset in local, regional and international mobility. Mobility of passengers and the free transport of goods is considered an essential element of modern society. With the integration of the world market, economic growth and higher levels of income, transport has become a major economic sector, which is characterized by qualitative and quantitative growth. For example, for the USA and Japan the

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contribution of the transport sector to GNP is estimated to be between 4 and 6% [1,2]. The contribution of transport for The Netherlands is estimated at around 8%, while for Europe as a whole this figure is around 7% [3]. However, this figure underestimates the importance of transport, since the significance of this sector is perhaps better demonstrated by noting that no economic activity can flourish without transportation. Facilitating mobility has become a prerequisite for the proper functioning of modern societies.

The transport sector is subject to dramatic changes. Various globalization trends and underlying factors influence developments in the transportation sector. The distance between production and (intermediate and final) demand is one of the factors determining the size of trade and respectively the demand for transport. As globalization affects the volume of consumption, production and the place of production, it has considerable impact on the volume of transport. Other influencing factors include the role of transport policy, but also non-transport policies and societal changes will have an impact. The increasing attention on market incentives in general and the move towards harmonization (a recent policy trend of the European Union) are aspects that may have significant impacts on the development of transportation. So the future of the transport sector is fraught with uncertainties, as the system can be influenced by many factors, which can develop in various ways.

The aim of this paper is to gain insight into the future developments of the transportation sector in 2020 on various geographical scale levels and caused by globalization. First, four possible developments of globalization were designed by applying a scenario approach. These global scenarios on the future development of the economy were developed in an earlier phase of research.[1] These future developments of the global world form the input for the transport scenarios, elaborated on three scale levels (global, European, Dutch) in this article. Outcomes of the assessment of these globalization scenarios, made on the basis of the *WorldScan* model of the CPB (Netherlands Bureau for Economic Policy Analysis), are used as inputs for establishing the transport scenarios [5]. We will not only describe these scenarios but their consequences will also be expressed in quantitative numbers of

[1]Referred to as Globalization, International Transport and the Global Environment (GITAGE). In a first phase four globalization scenarios were developed, the consequences for transport were translated into transport scenarios as being one of the tasks of this project funded by NWO (The Netherlands Organisation for Scientific Research), see also [4].

transported volumes in 2020 (in t/km for freight and passenger/km for passenger transport). This enables us to obtain more insight into the size of transport flows with a view to the estimation of future emissions of transport (cf. [6]). Transport movements can have substantial effects on environmental quality. The intensity of transport, the distances and the used modes of transport can have immense environmental impact. This is an extremely important challenge since many countries have committed themselves to the Kyoto Protocol agreement with the aim to drastically cut CO_2 emissions. Thus, the achievement of sustainable transport is a major policy objective, and therefore an exploration of alternative futures is needed.

This article is organized as follows. Sections 2 and 3 will deal with general remarks concerning transport and scenarios, and some theoretical aspects will also be discussed. The four global scenarios will be described in Section 4, using a common structure. Section 5 will drill-down these scenarios to the European level and Section 6 to the Dutch level. In Section 7 transport estimates for 2020 will be outlined whereas Section 8 shows the results. The article will close with some concluding remarks in the final section.

2. GLOBALIZATION

Globalization refers to the broad area of increasing internationalization of markets, changing consumption patterns and shifting industrial activities all over the world. Here this term is interpreted as the growing economic interdependence of countries worldwide through the increasing volume and variety of cross-border transactions in goods and services and of international capital flows and also through the more rapid and widespread diffusion of technology [5]. It affects capital flows, trade patterns and location choices of firms at a global and regional level. It could result in a drastic shift of production activities to specific regions. Moreover, increasing linkages between regions could affect the dissemination of new technologies and consumer preferences.

One way to deal with the uncertain impacts of globalization is to construct different scenarios as a useful tool for exploring this uncertain future. In the context of GITAGE, the globalization issues are identified in four scenarios. These address in various ways the process of globalization, its effects on the various regions, political cooperation between regions, the pace of technological progress [7],

changing consumption patterns and developments in the transport sector. The following section outlines each of these scenarios, based on an identification of the driving forces behind globalization (using the Delphi technique). This led to a geographical distinction between OECD and non-OECD countries. The scenarios are composed in such a way that they describe developments in both areas. (For a complete overview see [8] and [5]).

In the first scenario, called the Schumpeterian scenario, the high and accelerating speed of technological development is the most important force behind globalization. Strong competitiveness and internationalization of business are essential elements in this dynamic process, leading to high economic growth in nearly all regions in the world economy. Economic systems are increasingly market-oriented, induced by a strongly liberalized international trade. This scenario predicts favourable circumstances for high growth in OECD as well as non-OECD countries.

In the second scenario, called the Malthusian world, the OECD economy flourishes while non-OECD countries lag behind. This leads to a strong polarization between these regions. The prosperous economic situation in the OECD is the consequence of high technological progress and the liberalization of trade and capital. In non-OECD countries, unstable political systems, overpopulation and low incomes stimulate large migration flows towards the OECD countries.

The third scenario, the developing world, foresees strong economic centres in the non-OECD countries. In this scenario, growth will for the greater part take place in the non-OECD countries (at high environmental costs) instead of the OECD countries. This occurs mainly as a result of liberalization of goods, services and capital markets, and market oriented and outward looking government policies. The non-OECD countries go further in opening up and strengthening markets. Trade blocks will arise as a result of liberalization of trade and finance and the adoption of free market principles. On the other hand, the OECD countries are confronted with low economic growth rates caused by a limited availability of resources, labour shortage, and slow technological progress. In the end, the developing countries catch up with the developed ones.

The fourth scenario is the ecological scenario in which the qualitative and non-material aspects of life are more important. The emphasis is on happiness, the local environment and efficiency rather than an increase in income and the physical amount of goods. Norms and values are heading towards more awareness of environmental prob-

lems. Production and consumption are localized instead of internationalized.

These four globalization scenarios form the input for the transport scenarios outlined in the next section. In this context use has been made of the quantification of these global scenarios carried out by the CPB [5]. The *WorldScan* model has been used as an appropriate tool to analyse scenarios in which trade and trade liberalization and differences between regions are important. The quantitative outcomes were important in order to establish transportation flows in the future.

3. TRANSPORT SCENARIOS

This section presents the different transportation scenarios. These scenarios also focus on different spatial scales or levels – global, European and national (Dutch). The construction of these scenarios is intended to reveal insights into the future developments of the transportation sector because it is important to bear in mind that these developments are directly derived from those global scenarios. Following these scenarios a distinction is made between two regions (OECD versus non-OECD on a global scale). For reasons of consistency, this distinction led to the decision to maintain the division between two geographical areas also at a lower scale level. As a consequence, distinctions have been made in the description of the transport scenarios at a European level (EU – members of the European Union plus Iceland, Norway and Switzerland – versus non-EU) and at a national level (Randstad (the western part of The Netherlands) versus non-Randstad). This division at the Dutch level may at first sight appear difficult to sustain because globalization might have the same consequences for both areas, but in The Netherlands a strong economic distinction is recognizable between the core region (Randstad, where most of economic activity takes place) and the more peripheral zone (non-Randstad). Globalization might have differential impacts although we are aware that the magnitude of the difference (between Randstad and non-Randstad) is smaller compared to the other levels.

We have chosen to describe the scenarios in terms of transport flows. Each scenario ends with an overview of changes in transported volumes (expressed in t/km for freight transport and passenger/km for passenger transport within a geographical area) as the main result. In order to describe changes in transport volume properly, four main

aspects of transport form the background of the scenario descriptions: spatial organization, distance, technological development and modal split. Changes in these aspects are likely to have impacts on the growth in transport [9,10]. These indicators – expressed simply as positive (+), negative (−) or neutral (0) – formed the basis of the scenario description and resulted in an overview of expected impacts on transported volumes.

As a starting point we take the situation as it was in 1995; this is the reference situation. A (+) in transport volume for example will only indicate that it is expected that the volume of goods or persons transported by a certain mode within a certain area will grow compared to the reference situation. As a consequence, a double plus (++) means that a stronger positive development is expected. It is important to bear in mind, however, that the plusses do not necessarily have the same meaning for the various scenarios or within scenarios; equally, a (0) does not mean that the situation will not change during the period of time, indicating only that compared with the reference situation no significant change is to be expected.

The following section and subsections describe the various transport scenarios resulting in changes in transport volumes. The starting point will be the global level, followed by the European and national/Dutch scenarios. (For a broader and concise overview we refer to [11]).

4. GLOBAL TRANSPORT SCENARIOS

4.1. Global Growth

This scenario assumes a high level of economic growth in both OECD and non-OECD countries. A second assumption is that speed and flexibility of transport will not suffer from any barrier. These expected developments, mainly as a result of the high economic growth, will support growth of the transport sector. The spatial organization will be left mainly to the market and will result in lower barriers to the import of goods, services and capital. These lower barriers and the reduction in transportation costs and trade tariffs stimulate international trade and transport. This trend is facilitated by the strong increase in the usage of conventional transport modes and the completion of a high-speed rail network in Europe.

An assumed effect of the trend towards globalization of production and consumption is an increase in the average distance covered by the

TABLE I Expected changes in transported volumes for global growth

	Volume	
	OECD	*Non-OECD*
Freight		
Air	+ +	+ +
Road	+	+ +
Rail	+	+ +
Seaborne shipping	+ +	+
Inland shipping	+	+
Passenger		
Air	+ +	+ +
Road	+	+ +
Rail	+	+

Source: [11]

various transport modes in both geographical blocks – not only as a result of the change in transport flows, but also as a result of growing welfare and the development of new technologies. Worldwide mobility will increase, especially in the non-OECD.

The implementation of new technologies in combination with high economic growth rates will facilitate a considerable growth in mobility and transport. At all levels governments aim at stimulating economic growth and transport is considered necessary for this. Progress of new technologies is expected to be somewhat faster in non-OECD countries so they can catch up with OECD countries. Worldwide consumption and production of products will lead to increased flows in freight transport. Also passenger transport will grow in terms of trips made and distance covered. Higher income levels will allow people to make more journeys for consumption purposes, such as shopping and leisure.

This scenario projects a continued increase in freight transport concerning volume, speed and distance, especially for air and sea transport. With regard to passenger transport, we would expect continued growth in personal mobility. In the absence of strong regulatory policies, this leads to the supremacy of the car over marginalized public transport in urban regions and fierce competition between high-speed trains and aircraft in European travel. The developments described above, based on transport technology, spatial organization, distance and modal split, form the basis for forecasting the develop-

ment in terms of volume (tonne- and passenger-kilometres), as shown in Table I.

4.2. Global Core-growth

The difference in development between the two areas will affect the transportation sector. Within the OECD-sector a concentration of trade and transport will occur, whereas trade between those two blocks is decreasing. As economic progress is situated among OECD countries, demand for transport is high in these countries. Consequently, this leads to increased flows in freight and passenger transport. There is only a modest demand for transport in non-OECD countries, and therefore for some modes a relatively small increase of volume.

There is only limited international trade, also due to restrictions in import and foreign investments. Transport networks in OECD countries will develop considerably, including transfer points. Consequently, ports and mainports will become crucial with regard to the efficiency of these networks, performing as regional points of transhipment. The development of networks in non-OECD countries is lagging behind and there is no real concentration of spatial activities, mainly due to the non-market orientation and inward orientation of government policies.

In a growing economy, as expected in the OECD countries, there is often progress in new technologies. Such developments in air and rail technology will improve the current achievements of these sectors and become more important. As for passenger traffic, technological development will support the introduction of high-speed rail and thereby take over parts of the short distance air transport market in OECD countries. In the long run the high-speed rail network will be enlarged. High-speed rail and intercontinental air will be the fastest growing modes for passenger transport. Non-OECD countries will rely heavily on more conventional transport modes and techniques. Road transport retains its dominant position, mainly due to the lack of new technologies for other modes. This situation will not change because unfavourable market circumstances in the non-OECD will hold up the diffusion of new technologies from the OECD.

Due to the growing volume of transport flows, other/new modes will be used to transport the majority of goods so as to cover the new routes and reach new destinations. Technological progress will play an important role in facilitating this development, which will not be

TABLE II Expected changes in volumes transported for global core-growth

	Volume	
	OECD	*Non-OECD*
Freight		
Air	+ +	+
Road	+	+
Rail	+ +	+
Seaborne shipping	+ +	+
Inland shipping	+	+
Passenger		
Air	+ +	+
Road	+	+
Rail	+ +	+

Source: [11]

diffused to non-OECD countries. As a result non-OECD countries will rely on already available transportation modes and techniques. Road transport is still the dominant mode for passenger and freight transport in both OECD and non-OECD countries. Table II shows the expected relative changes in volumes transported.

4.3. Global Peripheral Growth

In this scenario, growth will for a greater part take place in the non-OECD countries, at high environmental costs. The trend towards globalization of production and consumption causes an increase in the average distance travelled mainly attributed to non-OECD countries. Goods will be transported to a greater extent within the OECD and non-OECD regions, rather than between them.

In this scenario, non-OECD countries will implement technologies imitated from OECD countries, which are still far ahead in terms of transportation technology. This means that more efficient transport can take place (for passengers as well as freight) and that the use of ICT will increase in non-OECD regions. The OECD countries are losing their lead, since there is no incentive for technological development due to the restrained economic and political situation. They will rely on existing techniques. New innovations are only made on a small scale. The strong economic growth and technological development in non-OECD countries stimulate growth of transport by road, air and shipping. Transport by sea and air will benefit from new available

TABLE III Expected changes in transported volumes for global peripheral growth

	Volume	
	OECD	*Non-OECD*
Freight		
Air	+	+ +
Road	0	+ + +
Rail	0	+
Seaborne shipping	+	+ +
Inland shipping	+	+
Passenger		
Air	+	+ +
Road	0	+ +
Rail	+	+

Source: [11]

techniques and the liberalization of trade. In OECD countries, on the other hand, there is medium growth in air and shipping.

The share in world production of the non-OECD doubles from about 25% to nearly 50% [5]. Global convergence of consumption patterns occurs, which will lead to a rise in distance covered by the various modes. These changes in technology and spatial organization have an impact on volumes of goods and passengers transported. Due to non-OECD countries catching up with the OECD, their transport volumes show an overall increase for both passengers and freight. There are, however, some variations between the various modes: road use will remain dominant by far, although sea and air transport will benefit from the liberalization of trade. Their volumes transported will increase but slightly less compared to road (and sea even more than air). Rail transport will grow, but far less. In OECD countries, volumes will not increase that much, in contrast to the previous scenarios. Road transport remains the dominant mode expressed in volumes, especially in terms of freight. Table III provides an overview of changes in volumes transported for this scenario.

4.4. Global Sustainable Growth

This scenario focuses on sustainability and environmental quality. This puts restrictions on the use of transport. As a consequence, there is only modest trade between various continents; there are not many incentives to eliminate trade barriers. This also limits the incentives for

technological development in the transport sector [5]. Transportation is more expensive as it is unfriendly from an environmental perspective. The length and direction of the transport flows will change towards shorter, more regional flows. The distances covered will decrease to some extent. The reason for this is the decrease in the use of leisure transport, due to steep price increases.

In this ecological scenario, the focus is on environmentally friendly technology forced by ecological awareness. The OECD countries will export environmentally friendly technology to non-OECD countries. Road transport will be one of the main attention points in making it more energy efficient, being the dominant mode in energy consumption. Technology will be aimed at facilitating the trend towards more collective transport. In an absolute sense, the progress of new technologies is expected to be even faster in non-OECD countries so that they will catch up with OECD countries. In general, new transportation technologies will be developed as a priority and applied in practice sooner than might otherwise be expected. In addition it needs to be stressed that the impact of new technologies on the transportation market depends on the potency of the new development and the speed of introduction. Most improvements are to be expected in the rail market; especially the performance of rail freight (currently experiencing a poor rate of performance) [7].

Concerning passenger traffic, technological developments will support the introduction of high-speed rail and take over parts of the short distance air transport market. The future of road transport is rather questionable in this respect. Substantial improvements can be expected concerning fuel and engine technologies. In general a movement can be seen from the use of individual modes towards collective transport modes, which means that public transport will benefit from this trend.

In relation to freight transport, the use of seaborne shipping will increase, since ports will become more important. Rail transport also will become more important as it can be regarded as relatively environmental friendly, especially in Europe where the high-speed network for passengers will be expanded. As road transport is important for short distances, it is used increasingly, although in a restricted manner (within certain boundaries and congested areas) and more efficiently (as a result of technology push). Air transport will stabilize in total although there are differences between regions. The emphasis on ecology will result in an almost constant level of transport in OECD countries and a modest growth of transport in non-OECD countries. The changes in volume are presented in Table IV.

TABLE IV Expected changes in transported volumes for global sustainable growth

	Volume	
	OECD	*Non-OECD*
Freight		
Air	0	0
Road	0	+
Rail	+	+
Seaborne shipping	+	+
Inland shipping	0	+
Passenger		
Air	0	0
Road	+	+
Rail	+	0

Source: [11]

5. EUROPEAN TRANSPORT SCENARIOS

The developments outlined above on a global scale have implications for a European level. Consequently developments in the OECD will have similar implications for transport in EU countries, the same holds for non-OECD countries and the non-EU countries. So, the contents of the scenarios might show some resemblance as again the same global scenarios form the input. Nevertheless, there are differences, which are only to be seen on this continent – for example, it could be expected that a scenario which emphasizes high-speed train developments might have a significant impact in Europe.

5.1. European Growth

This scenario assumes high economic growth rates in EU as well as non-EU countries. Production and consumption takes place on a European scale, resulting in a rise in transport flows within Europe. The non-EU countries should open up to allow foreign goods and foreign investment. By opening up, the dissemination of technologies from western Europe will be accelerated. European countries will grow towards each other and closer economic integration between rich and poor countries will result. Finally, the distinction between non-EU and EU will become weaker and expansion of the EU will become realistic. Because of the 'Europeanization' of production and consumption, it is likely that the average distance covered by the diverse

transport modes will increase. Economic growth in non-EU countries will lead to a convergence of consumer preferences towards the EU [5].

The progress of new transportation technologies in combination with high economic growth rates will cause an increase in mobility and transport throughout Europe. Since transport is assumed to be necessary to facilitate economic growth, national governments will stimulate the construction of public infrastructure. In particular the introduction and expansion of high-speed rail will have its impact and will cause a shift between transport modes. There are improvements to be expected concerning fuel and engine technologies in road transport, but these will not have a significant impact on the use of the car as a means of transport. There will also be a trend towards intermodal transport. Because of the growing volume of transport flows, other/new transportation systems will be used to transport larger quantities of goods and to cover the new routes, as well as to reach new destinations.

As a result of the prosperous economic situation in Europe, more expensive (but faster) transport modes will become more generally used. For passenger transport, this means that air and high-speed rail transport will be more widely used, and form a substitute for road transport, mainly in western Europe. For freight transport, an increase in performance is to be expected, and with the progress in transport technology, freight transport by rail will benefit from this development.

International specialization, together with the trend towards 'Europeanization', will lead to increased flows in freight transport. In passenger transport, growth also is foreseen. Due to the rise in income, people will make more trips for consumption reasons, including leisure and shopping. This, together with the growth in production, will lead to increased transport volumes: more people have to travel to work, education and training.

The development of Trans European Networks (TEN's) will influence the spatial organization in Europe since transport flows will concentrate on specific infrastructures, e.g. road and rail transport. As a consequence, transfer points in these networks will develop into large mainports, having the latest technology at their disposal. High-speed networks for rail transport will especially be implemented in the EU countries. The nodes in the TEN's will become the focal points of economic growth, production and population. The changes in volume are presented in Table V.

TABLE V Expected changes in transported volumes for European growth

	Volume	
	EU	*Non-EU*
Freight		
Air	+	+
Road	+ +	+ +
Rail	+	+ +
Seaborne shipping	+ +	+
Inland shipping	+	+
Passenger		
Air	+	+ +
Road	+	+ +
Rail	+ +	+ +

Source: [11]

5.2. European Core-growth

This scenario assumes that eastern European governments are not able to pursue market oriented and outward oriented policies. The political situation is unstable and leads to an introspective attitude in contrast to the EU development where high economic progress exists, resulting in a strong EU. The EU will succeed in reducing missing transport links, e.g. completion of the TENs. Apart from efficiency goals, new infrastructure links are built to ensure cohesion in the EU space (equity). As the non-EU countries are inward oriented and unwilling to participate, they will not be included in these networks.

Airports will expand in the booming regions, since air transport will be far more efficiently organized, mainly facilitating intercontinental transport. Consequently, mainports will become crucial, acting as intercontinental, national and regional points of transhipment. Economic activities will take place in and around these mainports and new techniques will be used to support the development of these transfer points. The development of networks in Eastern Europe lags behind, mainly due to the inward orientation of government policies, and there is no real spatial concentration of activities.

The distances covered for goods and passengers will increase within EU countries. The kilometres covered by air transport will show the fastest growth in freight transport, followed by the kilometres covered by passenger rail transport. The distance covered by road transport is growing too, but to a lesser degree because of the technological development of other logistics in commuter transport. In eastern

TABLE VI Expected changes in transported volumes for European core-growth

	Volume	
	EU	*Non-EU*
Freight		
Air	+ +	+
Road	+	+
Rail	+	0
Seaborne shipping	+ +	+
Inland shipping	+ +	0
Passenger		
Air	+	0
Road	+ +	+
Rail	+ +	0

Source: [11]

European countries, road transport will flourish as a result of the lack of other innovative transportation.

Technological progress is one of the driving factors behind economic growth in EU countries. Air and sea transport technologies will in particular improve in these sectors. New ICT techniques will facilitate the efficient operation of high-speed rail networks. Air transport, in turn, will improve in efficiency because of new air traffic control systems and improved communications. Technical progress will also take place in automotive systems but will solely relate to a lower consumption of fuel. Electric cars will improve, but a major breakthrough is not anticipated. Eastern European countries will rely on existing techniques. New techniques will be imported from other countries but on a small scale.

As a result of economic growth, more expensive (but faster) transport modes will become available for a wider public. This means that, for passengers, air and high-speed rail transport will become more popular compared to road transport. Freight will be organized more traditionally in the EU; road networks remain dominant, although the use of inland waterways increases. In terms of long distance freight transport, sea shipping and air transport become dominant supported by the development of networks and mainports. The demand for transport is paramount in the economic progress of the EU, leading to increased flows of freight and passengers. Eastern Europe has no flourishing trade. Governments do not stimulate infrastructure invest-

ments so they will still be mainly dependent on road transport. The changes in volume are presented in Table VI.

5.3. European Peripheral Growth

In the first two scenarios, a favourable picture of the EU countries was described. In this scenario, however, the emphasis will be on eastern Europe (the non-EU countries). The EU does not manage to generate important technology breakthroughs, which enables eastern Europe to make up arrears on the basis of existing conventional technologies. This means that the main energy-intensive technologies from the EU countries will be copied, due to the lack of energy-saving innovations. As a result, the demand for energy will rise substantially, resulting in an increase in emissions [8].

The EU countries will face a drop in economic growth, caused by a limited availability of resources and a slow-down in the progress of technological development. The Eastern European trade blocs will make sure that the main point of trade and transport shifts from the EU towards Eastern Europe. Moreover, they will start to develop their own networks, enabling them to meet the growing demand for goods and transport. As a result of the prosperous economy and growing trade in eastern Europe, the demand for goods and passenger transportation as well as the distances covered will rise. In western Europe, growth will be lower, due to the unstable economic situation.

New technologies will not be invented because of the restrained economic situation in the EU. Non-EU countries will copy existing innovations and technologies from the EU before introducing their own. The focus of non-EU countries will mainly be on bigger and more luxurious road vehicles, which will have a negative influence on the environment. Improvements in air transport are also to be expected, mainly because of the updating of current aircraft fleets to further ensure the safety of passengers. In rail transport, there will be a change from diesel to electric powered trains.

Some major changes in modal split are to be foreseen. In eastern Europe, the more expensive and faster transport modes will become available to a wider public. This means that a modal shift will take place from road passenger transport to rail, especially air transport. Major investments will be made in rail infrastructure, so that trains can use double instead of single tracks, resulting in an increasing number of passengers, since travelling by train is becoming far more con-

TABLE VII Expected changes in transported volumes for European peripheral growth

	Volume	
	EU	*Non-EU*
Freight		
Air	+	+ +
Road	0	+ +
Rail	0	+
Seaborne shipping	+	+
Inland shipping	0	+
Passenger		
Air	+	+ +
Road	0	+
Rail	0	+ +

Source: [11]

venient and efficient. However, the main growth is to be expected in road transport, being the transport mode with most capacity and lowest costs. It is also the mode that requires least effort in expanding, and meets the growing demand for transport of goods and passengers. EU countries will show a medium rate of growth in air and shipping because of the strong trend towards these transport systems and the lower tendency towards road transport.

Due to the economic situation in eastern Europe, the demand for goods will rise. Consumers in non-EU countries will change their consumption patterns in line with that of EU countries. This means that more goods will have to be transported, most likely over larger distances. In eastern Europe, passenger transport is likely to increase as well. In western Europe, the volume of transport flows will stay more or less the same. The changes in volume are presented in Table VII.

5.4. European Sustainable Growth

In contrast to the previous scenarios, this scenario concentrates on the environment. Environmental quality within Europe is regarded as the driving force. Economic growth is not neglected but is only important within the constraints of social wellbeing and an environmentally focussed quality of life. Society as a whole is aware of the need to create a sustainable form of development.

Production and consumption continue to take place mainly in the

EU. While local transport between regions predominates, development of the European-wide road networks stagnates. Trains will take over long distance travel and collective transport grows. In particular, rail/sea and air/sea movements will grow. Seen from this perspective, ports and mainports will largely affect the efficiency of multimodal transport and are vital in this development.

All over Europe, one can see that transport distances will remain stable and transport flows will be bundled. Air transport may retain its share as it is mainly used for international travel and long distances. Within Europe, passenger rail transport will take over distances that were formerly covered by air transport. For the transport of freight, the same holds true for inland and sea shipping. Road transport will also lose part of its share (more in passenger than in freight transport) because private transport will become more expensive.

This scenario foresees an important role for technological developments in realising a more sustainable society. Growing environmental awareness will accelerate the acceptance of new, less polluting, applications, often aimed at energy efficiency. The EU will export its technology to non-EU countries. Innovations affecting road transport will be higher in Eastern Europe than in the EU as the latter already own cleaner cars and trucks. In the EU more attention will be paid to energy efficient techniques and the application of new telematics (e.g. dynamic route information) to increase capacity of existing infrastructure. Innovations in logistics will improve multimodal transport and give a push to the transport of freight by rail and water. Railway and urban public transport will expand because of improved technological developments and increasing capacity of existing infrastructures. Environmental awareness will also be expressed by growth in collective transport modes in both EU and non-EU countries. The use of public transport (with regards to improvements in services and infrastructure) will grow in densely populated areas and bigger cities. Personal transport will lose market share and become less important. The growth of air passenger transport will be limited because of the construction of subsidized high-speed rail tracks all over Europe. In order to preserve the environment and to overcome resistance from society, this will mainly use upgraded tracks. Seaborne shipping and inland shipping will become more important as multimodal transport is carried out more efficiently because it is regarded as environmentally friendly.

In this environmental scenario, transportation will change as it is generally seen as a significant contributor to the environmental prob-

TABLE VIII Expected changes in transported volumes for European sustainable growth

	Volume	
	EU	*Non-EU*
Freight		
Air	+	+
Road	0	0
Rail	+	+
Seaborne shipping	+ +	+
Inland shipping	+ +	+ +
Passenger		
Air	0	+
Road	0	0
Rail	+ +	+

Source: [11]

lems in the society. It is anticipated that technology will help in reducing these negative effects and create a shift towards cleaner modes. Modest growth in transport is expected which is caused mostly by seaborne shipping, inland shipping and rail. The changes in volume are presented in Table VIII.

6. DUTCH TRANSPORT SCENARIOS

6.1. Dutch Growth

From an economic point of view, The Netherlands benefits optimally from globalization. High growth rates throughout the country are typical for this scenario. In addition to the progress of technological developments (aimed at facilitating economic growth), this causes a rise in demand for mobility and transport. The Dutch mainports benefit from the expansion of the infrastructure network, since they act as the most important transhipment points. By stimulating growth of mainports, intermodal transport will show an increase as well as international transport by air and high-speed rail.

In the process of globalization tendencies in the fields of commerce, production, knowledge and ICT, Europe plays the role of catalyst, thanks to the economic integration of Europe. The Dutch economy grows faster than the European average, thus increasing the importance and influence of The Netherlands within Europe. The Netherlands will start to co-operate more intensively with neighbouring countries.

Reason for this development is the strong position of the Belgian region Antwerp–Brussels–Gent and the Ruhr area in Germany.

As a result of the strong economic growth and new technologies in The Netherlands, it is likely that the average mobility and the consumption level of Dutch people will increase since people will have higher incomes. With this, the average distances covered by the diverse transport modes will increase for both passenger and freight transport.

Technological developments in The Netherlands result from this strong economic situation. Most improvements are to be expected in the field of rail transport. The introduction and expansion of the high-speed rail network will have its impacts and will cause a shift between the diverse transport modes for passengers. The main impact is that people will be inclined to live further away, e.g. in the northern part of The Netherlands, and use the high-speed train to travel to work. Public transport will improve and be more efficiently organized due to the adoption of new techniques, but it will still be unable to compete with personal transport. Growth can be expected in road transport. Mainly due to the individualization of people, the personal motorized transport mode is by far the most intensively used type of transport. Cars and trucks will still be polluting and technology is more aimed at convenience of transport than at energy efficiency of vehicles. For freight transport, the use of transport by air and sea will grow, since Amsterdam Schiphol airport and the port of Rotterdam are expanding. The Netherlands will grow in distributing goods to the rest of Europe. In particular, for freight transport within Europe, the use of air transport will be chosen more often. Road transport remains dominant and most widely used by transport companies.

Due to the strong mainport position of Amsterdam Schiphol airport and the port of Rotterdam, more terminals are needed to facilitate growth. These terminals will be equipped with the latest technologies to attract and process the diverse transport modes and flows. Multimodal transfer points come into existence, often in combination with commercial activities such as shopping centres and parking lots. The changes in volume are presented in Table IX.

6.2. Dutch Core-growth

In this scenario the Randstad (the core region) is growing faster than the non-Randstad area. The mainports benefit from the globalization

TABLE IX Expected changes in volumes transported for Dutch growth

	Volume	
	Randstad	*Non-Randstad*
Freight		
Air	+ +	+
Road	+ +	+ +
Rail	+	+ +
Seaborne shipping	+ +	+
Inland shipping	+	+ +
Passenger		
Air	+ +	+
Road	+ +	+ +
Rail	+ +	+ +

Source: [11]

and the liberalization of trade in OECD and EU countries. The rising demand for goods and transport causes an increase in transport flows through The Netherlands. The port of Rotterdam as well as Amsterdam Schiphol airport will benefit from this expansion. Because of this mainport-growth, intermodal transport will show an increase, as will international air and high-speed rail transport. Activities concentrate in the core area, especially around the mainports. The peripheral area will only benefit partially from this growth.

The separation of The Netherlands into two parts will be strengthened in this scenario. The main economic activities take place in the Randstad, whereas the non-Randstad area lags behind. The north-eastern part will be even more 'isolated' than it is at present, whereas the south-eastern part is not able to attract important industries. The Randstad is regarded to be the engine of the economy with the two mainports as boosters. This will attract all kind of new industries and have a negative impact on living conditions. People want to live just outside the core and commute into the Randstad where they work. The amount of t/km covered will increase, thanks to the increasing demand for goods (a result of the prosperous economic situation) and improvements in infrastructure. The importance of the mainports determines the spatial developments in infrastructure to a large extent.

Innovations in technologies only take place in the Randstad region, mainly in the field of transport technologies to support and stimulate the position of both mainports: Amsterdam Schiphol and

TABLE X Expected changes in transported volumes for Dutch core-growth

	Volume	
	Randstad	*Non-Randstad*
Freight		
Air	+ +	0
Road	+ +	+
Rail	+	0
Seaborne shipping	+ +	0
Inland shipping	+	+
Passenger		
Air	+ +	0
Road	+ +	+
Rail	+ +	+

Source: [11]

Rotterdam will be equipped with new technological innovations improving the efficiency of handling of goods. In the non-Randstad, innovations hardly take place, as there is no substantial economic development. In passenger transport the use of high-speed rail increases, being a convenient and fast transport mode between Amsterdam, Rotterdam, The Hague and Utrecht. Public transport becomes important in a congested Randstad to serve the underlying network. Technology makes it possible to operate an efficient light rail network in the Randstad.

Some changes in modal split take place in this scenario. In an absolute sense, the distances covered by road are increasing. In a relative sense, however, the distance will decrease as a result of pricing measures of the government and the introduction of comparable alternatives such as high-speed rail and Randstad rail. This causes an increase in passenger/km covered by rail transport. With the expansion of Amsterdam Schiphol airport, more destinations and carriers become available, causing a rise in the use of air transport.

The construction of truck-only lanes contributes to a large extent to the growth in t/km. On the other hand, new distribution techniques will reduce this growth. Inland shipping and rail will also carry out some transport, as Rotterdam will have good transport infrastructure at its disposal to distribute goods. Amsterdam Schiphol will rely on road transport for freight. The changes in volume are presented in Table X.

6.3. Dutch Peripheral Growth

This scenario is the opposite of the favourable situation described in the previous scenario for the Randstad. As a result of the decline of western Europe as a centre of economic gravity, The Netherlands has to give up its strong mainport and distributing position. In this scenario, the Randstad is a region in which there is economic growth, but not as much as in the intermediary zone and more peripheral region. The government stimulates the development of the more peripheral region by creating a favourable climate of establishment for firms, for instance by offering attractive locations to firms in this region. The size of the flows of goods changes relatively, but in an absolute sense they are still growing. This is mainly the result of the development of the eastern part of the country that is connected to Germany and part of the German transport network.

Industrial areas are located around the country but concentrated along corridors. The mainports are still important suppliers to the transport flows along these corridors, but their role compared to other European mainports is diminishing. Regional points of transfer will grow and become local centres of economic activities. The smaller, regional airports located outside the Randstad will become more important.

The distance covered by the diverse transport modes is growing, mainly as a result of the increasing economic activities in the non-Randstad region. The decrease of distance covered in the Randstad is not sufficient to compensate for the growth in other areas. The main part of the growth is a result of the inclusion of the eastern part of The Netherlands in German transport networks, for both freight and passengers.

Technological improvements take place mainly in the non-Randstad as the focus of the government is on the development of this region. The few transport-related innovations that take place will mainly be in the field of transport networks for different transport modes, especially the passenger rail network.

This scenario shows some changes in modal split. The use of air transport increases in the non-Randstad since there is growth in the use of regional airports; they enlarge their market share at the cost of Amsterdam Schiphol. In rail transport, a rise is to be seen in the more peripheral regions. A shift towards market intervention in rail transport leads to far more efficient connections, causing a substantial increase in the use of rail transport.

TABLE XI Expected changes in transported volumes for Dutch peripheral growth

	Volume	
	Randstad	*Non-Randstad*
Freight		
Air	0	+
Road	+	+ +
Rail	0	+
Seaborne shipping	0	0
Inland shipping	+	+ +
Passenger		
Air	0	+ +
Road	+	+ +
Rail	+	+ +

Source: [11]

The use of seaborne shipping decreases, since the port of Rotterdam will lose its position as one of the most important players in the European mainport network. There is a substantial increase in the importance of Delfzijl harbour as a centre of gravity in the European network. The use of inland shipping increases to supply the new densely populated areas in the eastern part of the country. The overall volume transported increases in this scenario. In the Randstad, volume does not rise that much. It is still slowly growing, but not as much compared with the previous scenarios. The changes in volume are presented in Table XI.

6.4. Dutch Sustainable Growth

Sustainable growth is the main driving force in this scenario. People and firms are conscious of the fact that their behaviour directly influences the ecological and social wellbeing of the world. Firms implement new sustainable technologies as the focus is on sustainable development to remain ahead of their competitors. The strong social environmental awareness makes the distribution function of The Netherlands less prominent, although it is still present as the country has a favourable geographical position.

In order to reduce the physical transport of goods, government stimulates the spatial concentration of functions. The demand for new houses and industry locations requires the development of new urban areas in the vicinity of and along the corridors between existing cities.

These new urban areas form spatial concentration points and important transport junctions.

As a result of the emphasis on the 'quality of life', the movement patterns of persons and goods will change. People are more aware of the impact of transport on the environment, so they try to use more environmentally friendly transport, e.g. public transport. People cover the distance between home and work three times a week at most so the average distance covered in passenger kilometres decreases. Nevertheless, the demographic growth annuls this reduction, and results in a small net increase. For goods, transport is mainly bundled, which leads to a decrease in the number of movements per product. The relative importance of Rotterdam as a port of transhipment decreases, since the accent moves to value added logistics.

Technological development in The Netherlands is significant and almost completely devoted to the environment. The government will only accept new technologies if they make a substantial contribution to the solution of environmental problems. Improvements are to be expected in the field of environmentally friendly modes such as rail transport. The introduction and expansion of the high-speed and light-rail network will cause a shift between the diverse transport modes for passengers. International flights will be taken over by high-speed rail transport wherever possible.

Infrastructure networks for freight transport will be used more efficiently and junctions will be optimized. Since flows of goods are more and more bundled, points of transhipment are utilized with the latest technologies. In rail transport, there is a development towards the use of rail shuttles and road trains with automatic guidance. Telematics will be widely implemented and used, offering new possibilities to substitute for physical transport.

The shift in modes is mainly a result of the environmental awareness of people. They have clear insight into the extent to which vehicles are polluting, so road transport will be negatively affected. In passenger transport a shift from the use of the car towards the high-speed rail network is perceived. In addition public transport is used intensively for commuter and leisure trips. In freight transport, the flows of products are bundled so that transport modes are used more efficiently. The decentralization of production and consumption requires efficient transport systems for middle-long and longer distances. Inland waterways and rail benefit from this development. Overall only a modest growth in volumes transported can be expected. The changes in volume are presented in Table XII.

TABLE XII Expected changes in transported volumes for Dutch sustainable growth

	Volume	
	Randstad	*Non-Randstad*
Freight		
Air	0	0
Road	+	0
Rail	+	+
Seaborne shipping	0	0
Inland shipping	+	+
Passenger		
Air	0	0
Road	0	+
Rail	+ +	+

Source: [11]

7. TRANSPORT ESTIMATES FOR 2020

This section describes the calculation of quantitative transportation estimates (in tonne-kilometres and passenger kilometres for the various modes) for the year 2020 as an outcome of the twelve scenarios. To achieve this, the results of the *WorldScan* model have to be taken into account [5] since these can be seen as a constraint to growth in transport. The subsections which follow describe the various steps made in order to determine the final estimates. First, the growth in the volume of transport will be calculated on the basis of *WorldScan* data. This will be followed by an explanation of the allocation of expected volume changes leading to concrete volumes for each transport mode in 2020.

7.1. Growth in Transportation

Calculating estimates for the various transport modes would be easy if the growth figures for transportation would have been available. Unfortunately *WorldScan* does not contain these transport sector results. So it is necessary to construct a link enabling us to relate the *WorldScan* outcomes to the transportation data and scenarios. Growth in GDP and trade were selected as affecting the growth in transport. We are aware though that other aspects (such as the composition of the economy) are also relevant in estimating transport volumes, especially

to incorporate the differences between scenarios. But for reasons of simplicity we chose not to take these aspects into our estimations.

The correlation between GDP and transport is apparent although the direction of causation is less clear [12]. Besides, it is less easy to identify the exact relationship between growth in GDP and growth in transport volume. The latter is exactly what we need to define, i.e. a one per cent growth in GDP means *X%* growth in transport volume for a certain mode over a certain period. This correlation varies by country and over time, but literature offers some insights. When these figures are available we can allocate the growth to the various modes according to the results as presented in the tables in Sections 4, 5 and 6. First, we discuss the available growth figures in GDP. After this, the growth in trade will be incorporated in the establishment of the growth factors.

Table XIII shows GDP growth rates (average annual growth rates between 1995 and 2020). These data are directly derived from *WorldScan* results and transferred into overall growth rates, enabling us to calculate the overall growth in transport volumes in a next step. The data for The Netherlands cannot be derived directly from the *WorldScan* model. Based on [13] we assume that the labour force will grow faster than the average growth in Western Europe in the Growth and Core growth scenarios. This will lead to an annual average growth rate that is somewhat higher than the Western European level [13]. For the other scenarios no differences in growth of the working population are to be expected, so these will not change (see Table XIII). As growth figures at the Dutch level are not really different and difficult to define, only the GDP growth for The Netherlands as a whole is incorporated. It is assumed that those data are the same for both geographical areas.

In order to define the relationship between growth in GDP and transport volume, literature is used as a guiding tool. Estimates of the long-term elasticity of demand for transportation offer useful insights [14]. An example of elasticity between income (consumer expenditures) and two transportation factors is presented below. Table XIV shows that the income effect on road transportation varies between 0.88 and 1.04. This indicates that a value of around one (one per cent growth in GDP is accompanied by a 1% growth in road transport per year) is not unusual. An overview of GDP growth (per capita) and travel and freight mobility provided by [12] shows somewhat comparable results. However, another study [15] shows a decoupling (around 0.8) over 10 years for The Netherlands between GDP growth and

TABLE XIII Average annual GDP growth rates and absolute overall GDP growth rates between 1995 and 2020 (%)

Transport		*Growth*		*Core growth*		*Peripheral growth*		*Sustainable growth*	
		Av.	*Abs.*	*Av.*	*Abs.*	*Av.*	*Abs*	*Av.*	*Abs*
Global	OECD	2.6	90.0	2.6	90.0	1.2	34.7	1.2	34.7
	Non-OECD	6.2	350.0	3.6	142.1	5.9	319.2	4.0	166.6
Europe	Western Europe	2.3	77.4	2.3	77.9	0.6	16.1	0.8	21.4
	Eastern Europe	4.7	213.8	1.8	57.8	4.8	222.9	2.4	79.6
The Netherlands	Randstad	2.4	79.1	2.4	79.6	0.6	16.1	0.8	21,7
	Non-Randstad	2.4	79.1	2.4	79.6	0.6	16.1	0.8	21.7

Source: [5] and own calculations

TABLE XIV Long term transportation demand elasticities

	USA/income	*Europe/income*
Distance travelled	0.88	1.04
Total freight (t/km)	1.00	0.99

Source: [14]

international goods transportation expressed in t/km. So factors between 1.5 and 0.5 for total transport seem reasonable.

Another aspect that has to be included here is the growth in volume of trade as expected by the *WorldScan* model. The quantity of transport also depends on the amount of trade between countries. Table XV shows the average annual growth in volume of trade derived from *WorldScan* (no data for The Netherlands available). It can be seen that especially in the Growth scenario there is a large growth in trade.

In establishing the growth factor, a distinction between the various scenarios and the scale levels is made. It can be expected that the factors will vary over scenarios and world regions, also due to growth in GDP and trade. The sustainable growth scenario, for example, is aimed at sustainability. It is therefore understandable to expect a relative decoupling between growth in GDP and the transport volume. Furthermore, one might assume that this decoupling would be stronger in OECD countries than in non-OECD countries because of earlier adoption of new technologies. This clarifies the lower factors between prosperous and less prosperous regions. In addition the trade figures suggest a higher factor in the growth scenario than in the others. Taking into account the foregone aspects and based upon our own insights we derived the following factors, presented in Table XVI, for the whole transportation sector (both passengers and freight). The value 1.3, for example, means that the absolute growth in transport volumes is 30% higher compared to growth in GDP in OECD

TABLE XV Average annual growth in volume of trade between 1995 and 2020 (%)

Transport		*Growth*	*Core growth*	*Peripheral growth*	*Sustainable growth*
Global	OECD	5.6	3.1	2.5	2.4
	Non-OECD	8.6	3.2	6.0	4.0
Europe	Western Europe	5.9	3.0	2.5	2.5
	Eastern Europe	5.6	2.2	3.9	2.4

Source: [9]

TABLE XVI Overall growth factors (cumulative elasticity for a 25-year period) in the transport sector with 1% growth in GDP

Transport		*Growth*	*Core growth*	*Peripheral growth*	*Sustainable growth*
Global	OECD	1.3	1.1	0.7	0.6
	Non-OECD	1.2	0.8	0.9	0.8
Europe	Western Europe	1.4	1.2	0.9	0.6
	Eastern Europe	1.2	1.0	1.0	0.8
The	Randstad	1.5	1.5	1.0	0.5
Netherlands	Non-Randstad	1.4	1.2	1.4	0.5

countries for the Growth scenario for this 25-year period. We will not make a distinction between modes and passenger and freight transport as clear insights in this distribution are missing.

The next step is to determine the overall growth in transportation volume. This is done by taking the absolute growth figures as presented in Table XIII and multiplying these with the growth factors from Table XVI. The results are shown in Table XVII, where growth in passenger and freight transport is determined. It can now be allocated to the various modes, based on the outcomes of each scenario.

7.2. Allocation of Transport Growth

We now know the growth in total transport. The next step is the division of growth over the various modes of transport. The distinction between passenger and freight transport is necessary in the allocation since they are expressed in different units (passenger/km and t/km). The method used to determine the volume of the various modes from the data in Table XVII can be explained by an example and will be summarized mathematically.

TABLE XVII Absolute growth in volume of the transport sector, 1995–2020 (%)

Transport		*Growth*	*Core growth*	*Peripheral growth*	*Sustainable growth*
Global	OECD	117	99	24	21
	Non-OECD	420	114	287	133
Europe	Western Europe	108	93	14	13
	Eastern Europe	256	58	223	64
The	Randstad	118	119	16	11
Netherlands	Non-Randstad	111	95	23	11

Assume that:

Q_{A0} = volume transported by air 1995
Q_{At} = volume transported by air 2020
Q_{R0} = volume transported by road 1995
Q_{Rt} = volume transported by road 2020
Q_{S0} = volume transported by rail 1995
Q_{St} = volume transported by rail 2020
Q_0 = total volume transported 1995
Q_t = total volume transported 2020
g = growth factor from Table 17
A^+ = number of (+)ives in the scenarios (Tables I–XII respectively)

For example, suppose that: the total volume transported in 1995 is 3.5 million passenger/km; air will grow with two (+)ives (+ +); road will not grow (0); and rail transport grows with one (+)ive. Note that a (+)ive relates to the relative growth with regard to the data in 1995. Growth will be 100%, so g is equal to 2. The total amount of transport in 2020 is then 7 million passenger-/km. The numbers that now need to be derived are Q_{At}, Q_{Rt} and Q_{St}. This is shown schematically in Table XVIII.

TABLE XVIII Example of the calculation

Mode	Q_0 *(0 = 1995)*	*Amount of plusses* (A^+)	Q_t*(t = 2020)*
Air	1 million	2	Q_{At}
Road	2 million	0	Q_{Rt}
Rail	0.5 million	1	Q_{St}
Total	3.5 million ($Q_{t,0}$)	3	7 million (g = 2)

In general mathematical notation this example can be expressed as follows (which can be applied for m modes, with $Q_{m,o}$ being the volume transported in the base year for mode m and A_m^+ the number of (+)ives for each mode m):

$$\sum_m Q_{m,o} = Q_{t0} \tag{1}$$

$$Q_{t,t} = g\ Q_{t,0} \tag{2}$$

$$\sum_m Q_{m,o} A_m^+ X = (g-1)\ Q_{t,0} = Q_{t,t} - Q_{t,0} \tag{3}$$

$$Q_{m,t} = Q_{m,o} A_m^+ X + Q_{m,o} \tag{4}$$

$$X = \frac{(g-1)Q_{t,o}}{\sum_m Q_{m,o} A_m^+} \tag{5}$$

Equation (5) denotes the value given to X, when all the other variables are known. X can then be used to calculate the unknown values for Q (transport by various modes in 2020). This enables us to present all the values for the various modes expressed in passenger/km and t/km. In this illustration for 2020, 3.8 million passenger/km will be made by air, road traffic will not grow but remain at 2 million and rail traffic will be 1.2 million passenger/km.

8. RESULTS

One prerequisite for carrying out this analysis is to have base data (in this case data from 1995 for all modalities in tonne and passenger kilometres). While gathering these data, it appeared that this information is not available in the required format. It was hard to obtain transport data especially for non-OECD countries. Also at the Randstad and non-Randstad level some assumptions had to be made in order to carry out the analysis. From various statistics [15,16,17], [18,19], [20], [21], [22] and [23,24] it appeared impossible to find inland waterway data for non-OECD countries. Besides, it was too complicated to allocate sea transport at a Dutch level. The estimates below indicate this fact with a zero.

Figure 1 presents the results of the different scenarios at different scale levels by index number (1995 = 100). So, for example, it is foreseen that road freight transport in western Europe will grow in the growth scenario by 118% by 2020. As one can see, in most cases transport will grow in the next 25 years, while in some cases it remains unchanged. However, this does not mean that the volumes transported are constant during this 25-year period and fluctuations are likely to occur in between.

The figures show clearly that the growth scenario is likely to cause the largest growth in volumes transported for both passenger and freight transport and at each scale level. The relatively less developed regions will in particular show strong growth. These regions will also show growth in passenger and tonne kilometres in the peripheral growth scenarios but not to the same extent as in the growth scenario. The increase in volume in the sustainable growth scenario is relatively modest whereas the less developed regions may show some increase in transport. This growth is to be expected for the 'greener modes' since road transport is limited. Societal awareness towards a more environmental friendly behaviour is the major cause of this development.

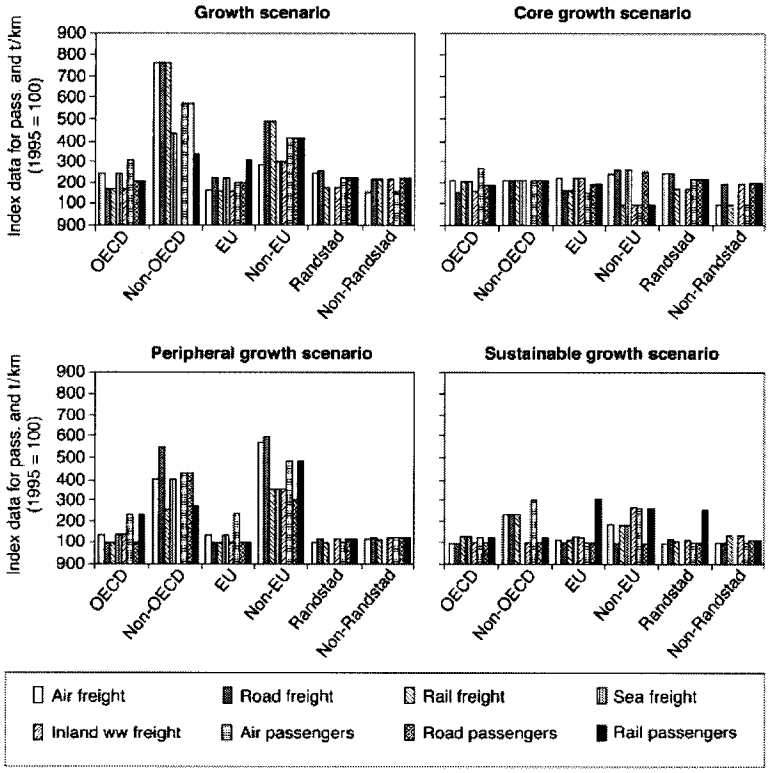

FIGURE 1 Overview of the outcomes in 2020 for four selected scenarios (1995 = 100).

Examining the various scale levels, it appears that growth in transport is in general larger at a global level, especially air transport. All four scenarios show that on a European level transport will not decrease. In particular, transport in the non-EU countries will show an increase. Even in the core growth scenarios some modes will grow faster than in western Europe. The passenger transport market is characterized on a European level by a significant growth of rail transport. The difference between growth in the Randstad and non-Randstad does not seem that big (except for air transport, caused by the fact that the most important airports are located in the Randstad).

9. CONCLUSION

There is growing awareness that in the long term, the development of society is characterized by substantial uncertainties. This often makes a prognosis-based approach inadequate. Scenario analysis is used in long-range policy research, since it provides a way of identifying future issues and problems for policymaking in an environment of qualitative uncertainty. Scenarios can be regarded as descriptions of possible futures that seem plausible under different sets of assumptions and provide a background against which policy assessments can be made. Scenarios are important tools for strategic policy analysis, especially in situations where policymakers have too much biased and unstructured information. The transport sector is one of those fields where policymakers have to deal with many uncertainties. Despite these uncertainties, policymakers face the pressure of having to achieve sustainable mobility and consequently need to have insight into future developments.

This article presented possible future developments by sketching four contrasting global images resulting from expected developments driven by globalization. At various scale levels the impacts are estimated for the transport sector, and expressed in volumes transported for both passenger and freight transport. It appears that all scenarios foresee a growth in transport volumes world-wide compared to 1995. In general the strongest growth can be seen in the Growth scenario. This can be explained by the high rate of economic progress in both parts of the world (OECD and non-OECD), which is likely to lead to a substantial increase in volumes transported. On the other hand, transport will grow modestly or not at all (for certain modes) in the Sustainable Growth scenario. This scenario also foresees a modal shift with rail and water transport taking over a share of road and air transport. This is valid for freight as well as passenger transport. The Core Growth scenario foresees strong growth in volumes transported for the developed regions, whereas Peripheral Growth expects a growth in transport to take place in the more developing regions.

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